CLAIMS

What is claimed is:

1. A method for determining a pointing error of an object attached to a shaft, comprising:

    providing a set of distance measuring probes at each end of the shaft;

    using the probes, measuring a position of each end of the shaft for producing shaft-end position data;

    determining a geometric error vector for each end of the shaft from the shaft-end position data; and,

    using the geometric error vector, determining the pointing error of the object.

2. The method as in claim 1, wherein determining the geometric error vector comprises:

    referring to a source of characterization data comprising repeatable error data to obtain a repeatable error component corresponding to a location of the shaft; and,

    subtracting the repeatable error component from the position data to produce a non-repeatable error component.

3. The method as in claim 2, further comprising calculating angular error, Δ_{az}, Δ_{el}, from the non-repeatable error component.

4. The method as in claim 3, further comprising calculating the pointing error, *MOA_ERROR*, from the angular error, Δ_{az}, Δ_{el}.

5. The method as in claim 1, wherein providing the set of distance measuring probes comprises providing a first probe of the set to be disposed at an angle of about 90 degrees to a second probe of the set.

6. The method as in claim 1, wherein the geometric error vector indicates an angular position and a magnitude of an error producing feature of the shaft.

7. An apparatus for determining a pointing error of an object attached to a shaft, comprising:

a set of distance measuring probes disposed at each end of the shaft adapted for monitoring a position of the shaft and producing shaft-end position data, the set of distance measuring probes being coupled to a processor for receiving the shaft-end position data and determining a geometric error vector for each end of the shaft and using the geometric error vector, determining the pointing error of the object.

8. The apparatus as in claim 7, wherein the shaft is disposed aboard a spacecraft, and where the object comprises a mirror.

9. The apparatus as in claim 7, wherein the object comprises at least one of a telescope, a mirror, a laser, a laser transceiver, and an angular measurement device.

10. The apparatus as in claim 7, wherein the set of distance measuring probes comprises a set of eddy current proximity sensors.

11. The apparatus as in claim 10, wherein the set of eddy current proximity sensors comprises dual channel eddy current proximity sensors.

12. The apparatus as in claim 7, comprising a first bearing assembly coupled to respective ends of the shaft.

13. The apparatus as in claim 12, comprising a gimbal coupled to the first bearing assembly.

14. The apparatus as in claim 13, comprising a second bearing assembly coupled to the gimbal.

15. The apparatus as in claim 14, wherein the set of distance measuring probes is adapted for monitoring at least one of the gimbal and a position of at least one of an inner ring and an outer ring of a respective bearing assembly.

16. The apparatus as in claim 7, comprising at least one flange for monitoring by the set of distance measuring probes.

17. The apparatus as in claim 16, wherein the at least one flange comprises one of passivated steel, aluminum and titanium.

18. The apparatus as in claim 7, wherein the apparatus is adapted for shielding the set of distance measuring probes from thermal effects.

19. A method for characterizing a repeatable position error in a pointing device attached to a shaft supported by bearings, comprising:

providing a set of distance measuring probes at each end of the shaft;

setting the shaft to a predetermined location;

measuring a position of each end of the shaft at the predetermined location for producing position data;

determining a geometric error vector from the position data for each end of the shaft;

using the geometric error vector, determining a pointing error of the pointing device;

storing the pointing error for each predetermined location to establish a pointing error record;

repeating the determining of the pointing error until a new determination of pointing error for a predetermined location is within an acceptable tolerance for agreement with the pointing error record; and,

identifying the pointing error stored in the pointing error record as repeatable position error data.

20. The method as in claim 19, wherein the measuring is performed at a predetermined temperature.

21. The method as in claim 19, wherein the pointing device is disposed aboard a spacecraft.

22. A computer program product stored on a computer readable storage medium, comprising computer readable program code instructions to determine a pointing error of an object, the instructions comprising steps for:

producing measurement data for a location of the object by measuring a position of a shaft with a set of distance measuring sensors disposed at each end of the shaft to which the object is attached;

determining a geometric error vector for each end of the shaft from the position data; and,

using the geometric error vector, determining the pointing error of the object.

23. The computer program product as in claim 22, further comprising instructions for communicating at least one of the measurement data and the pointing error to a remote station.

24. A method for determining pointing error of a pointing device, the method comprising:

providing the pointing device attached to a shaft, the shaft coupled to a first bearing assembly rotating about a first axis, and coupled to a second bearing assembly rotating about a second axis, and a set of distance measuring sensors adapted to monitor the position of the pointing device;

measuring the position of the pointing device along the first axis and the second axis to produce position data, *ds*;

retrieving repeatable error data from a source of calibration data to produce a repeatable error component;

subtracting the repeatable error component from the position data, *ds*, to produce a non-repeatable error component, *ads*;

using the non-repeatable error component, *ads*, computing a first axis position error, Δ_{az}, and computing a second axis position error, Δ_{el}; and,

computing the pointing device error, *MOA_ERROR*, as

$$MOA\_ERROR = \begin{bmatrix} \Delta_{azy}.\cos(el + \pi / 4) - \Delta_{el}.\sin az \\ -\Delta_{azx}.\cos(el + \pi / 4) + \Delta_{el}.\cos az \\ \sin(el + \pi / 4)(-\Delta_{azy}.\cos az + \Delta_{azx}.\sin az) \end{bmatrix}$$; where Δ_{azy} denotes a y-axis component of the first axis position error, Δ_{az}; Δ_{azx} denotes a x-axis component of the first axis position error, Δ_{az}; *el* denotes an angle in the second axis, and *az* denotes an angle in the first axis.

25. A method for compensating for pointing error in a pointing device attached to a shaft of a spacecraft, comprising:

providing a set of distance measuring probes at each end of the shaft;

measuring a position of each end of the shaft for producing position data;

determining a geometric error vector for each end of the shaft from the position data;

using the geometric error vector, determining the pointing error of the pointing device;

using the pointing error to adjust one of a position of the pointing device and a set of data produced by the pointing device.